

The Impact of Planetary Rotation Rate on the Reflectance Spectrum of Terrestrial Exoplanets

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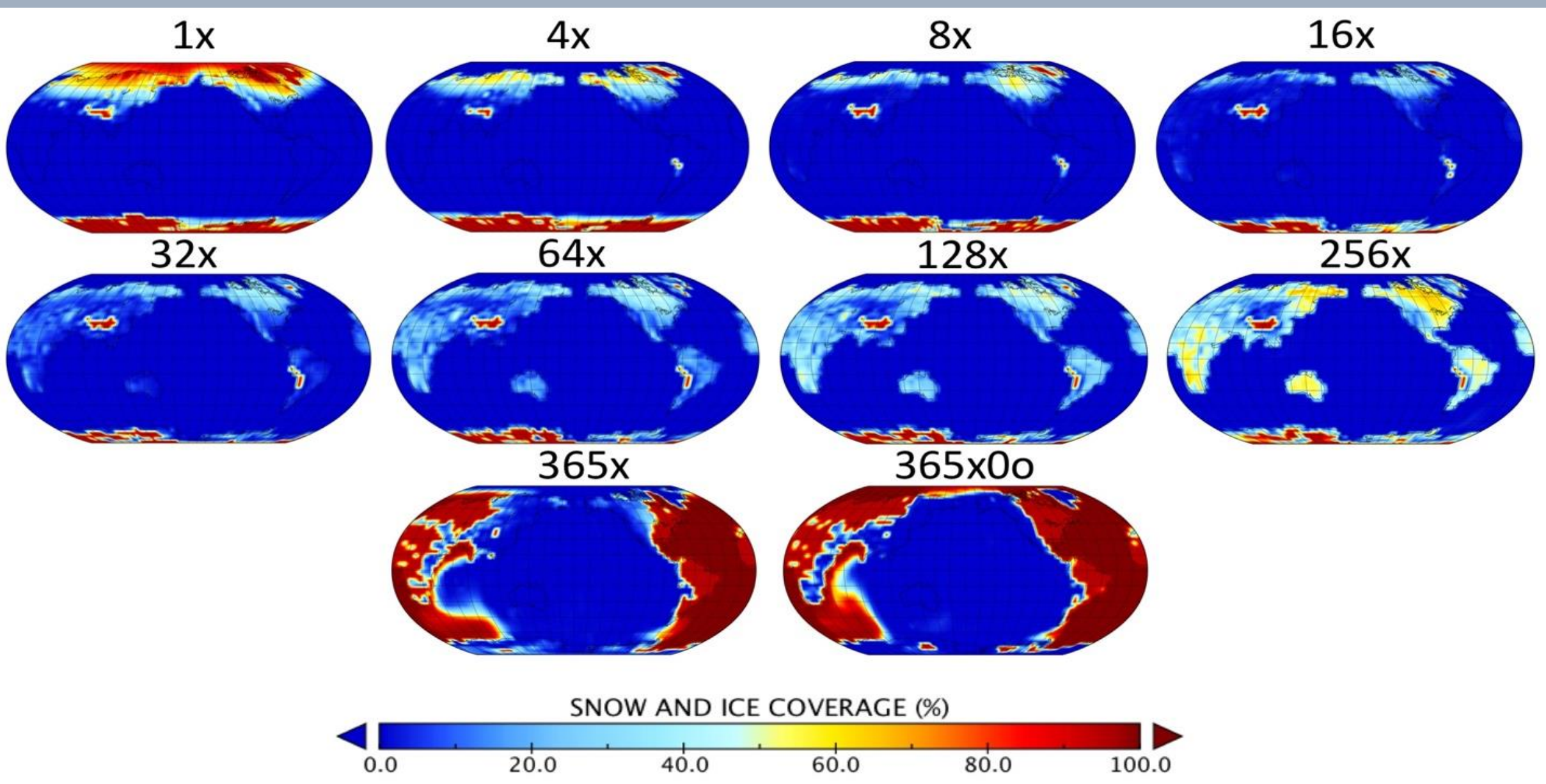
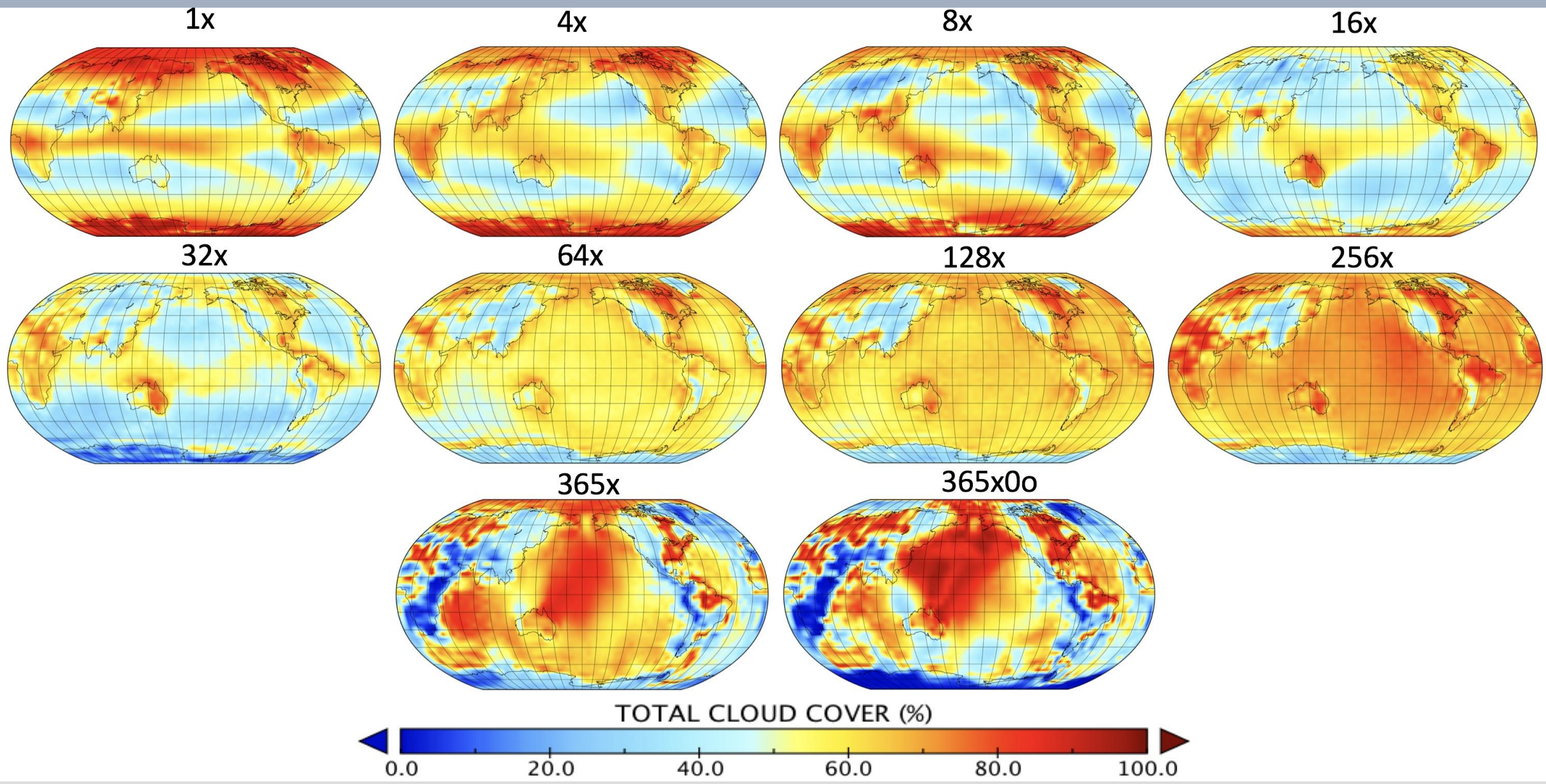


Introduction:

- Observations of terrestrial exoplanets with future space telescopes like LUVOIR or HabEx will see a complex spectrum with numerous aspects of the planet's orbit, atmosphere, and surface creating degenerate features in a visible and near-infrared spectrum.
- We investigate how planetary rotation rate impacts the spectrum of an Earth-like planet by simulating planetary climate with the ROCKE-3D global climate model and flowing the output through two radiative transfer models: SMART and the Planetary Spectrum Generator.

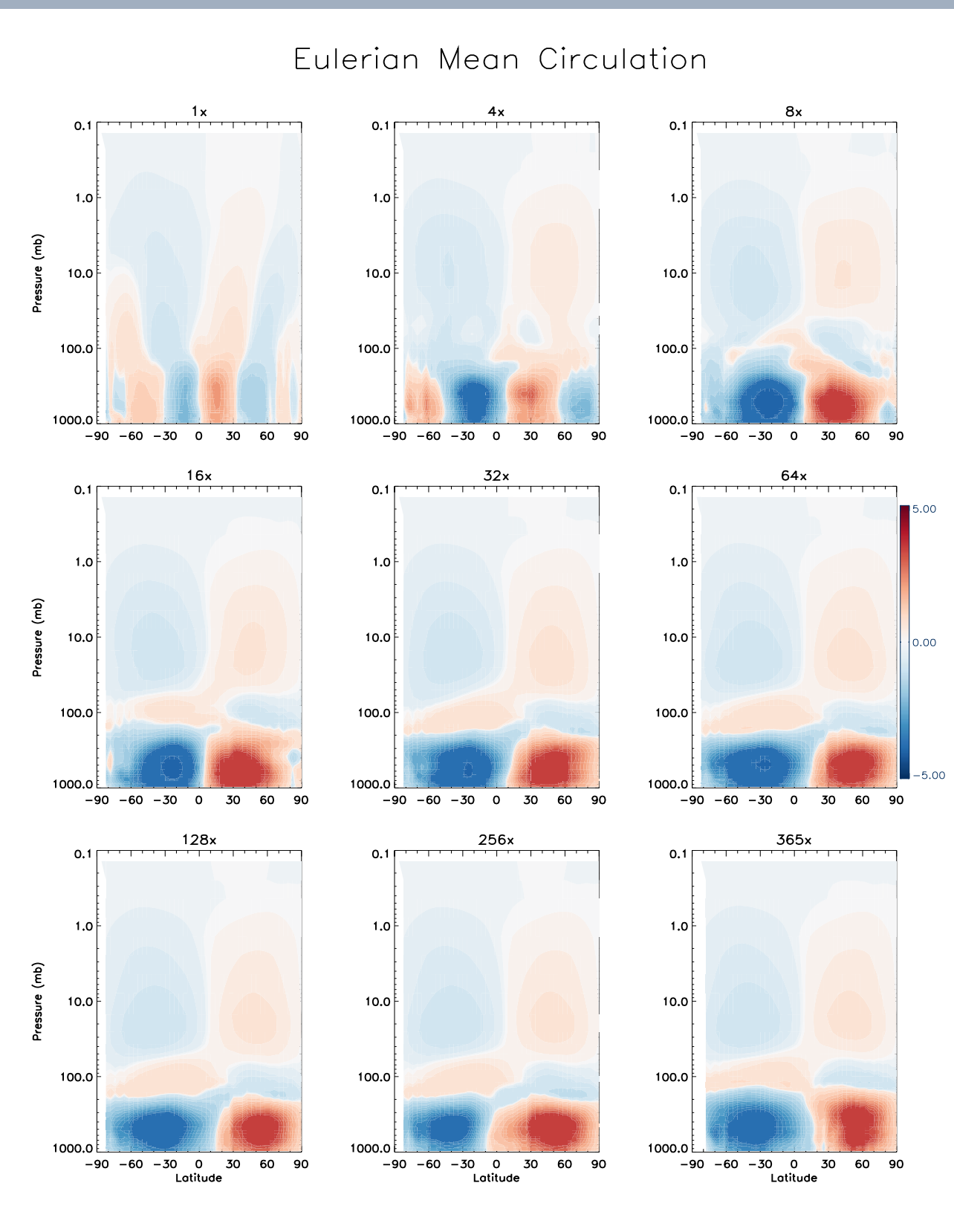
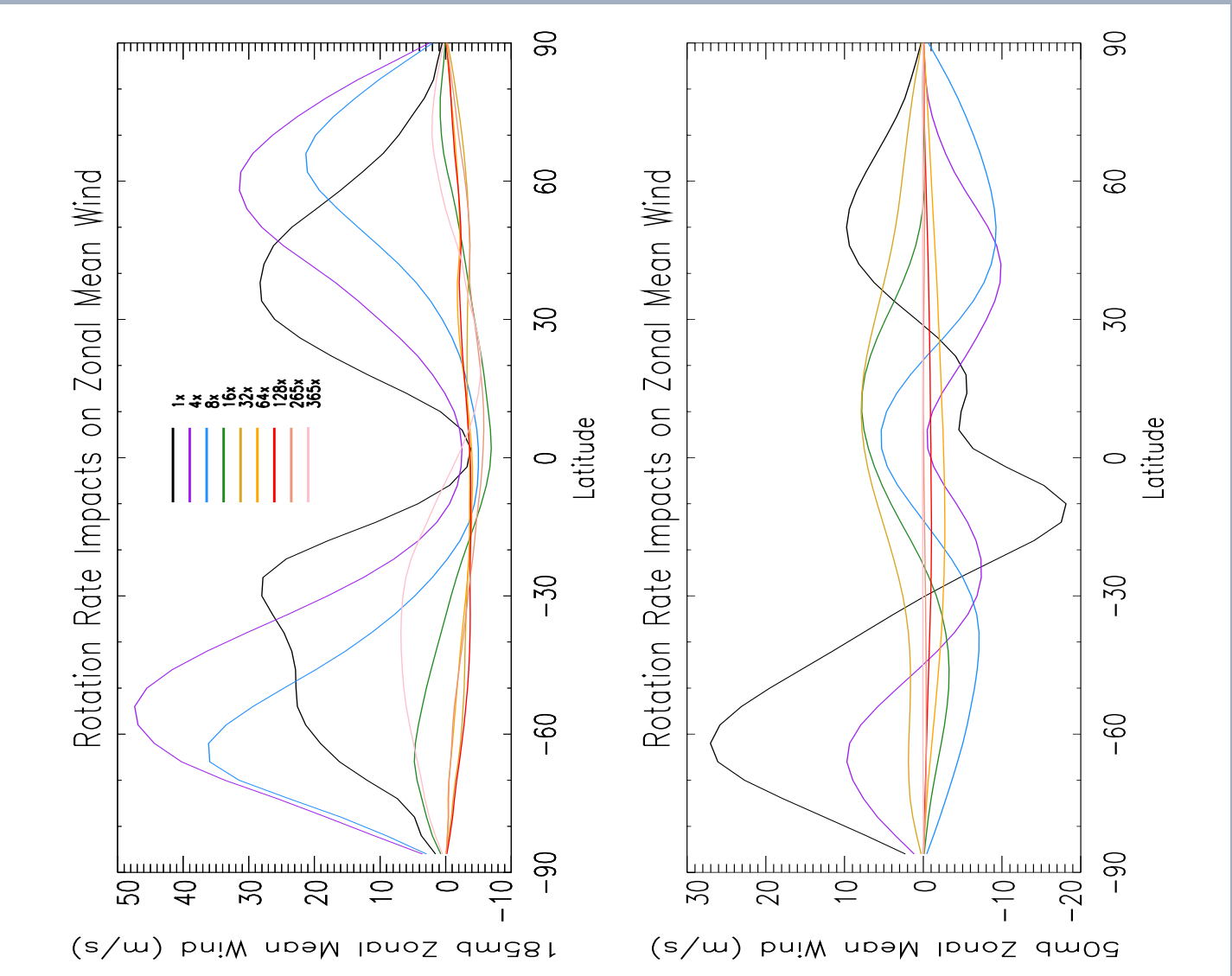
Changes to Cloud and Surface Snow/Ice Cover:

- Multi-year average cloud and ice coverage decreases from Earth-like day length (1x) through 32x day length before increasing again at longer day lengths (64x through 365x).



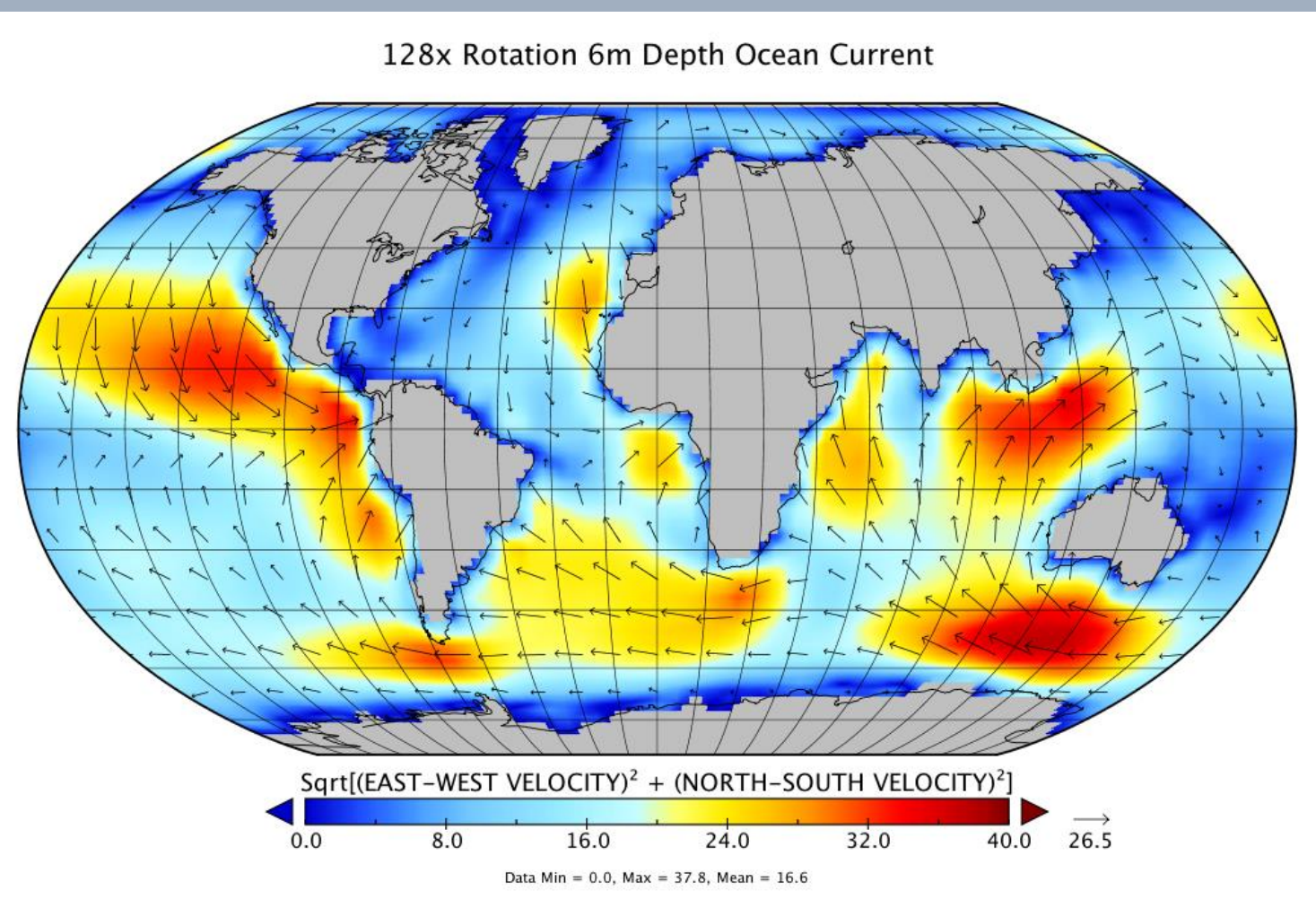
Changes to Atmosphere and Ocean Circulation:

Atmosphere



- Atmospheric super-rotation occurs in the stratosphere at 4x-32x day lengths. At longer day lengths, atmospheric flows weaken.
- Hadley circulation becomes equator-to-pole near 8x day length. Ferrel cells are absent at slower rotation rates.

Ocean



- At slower rotation rates/longer day lengths, major current flows (e.g., Gulf Stream) are absent and the Antarctic Circumpolar Current is reversed from the Earth-like simulation.

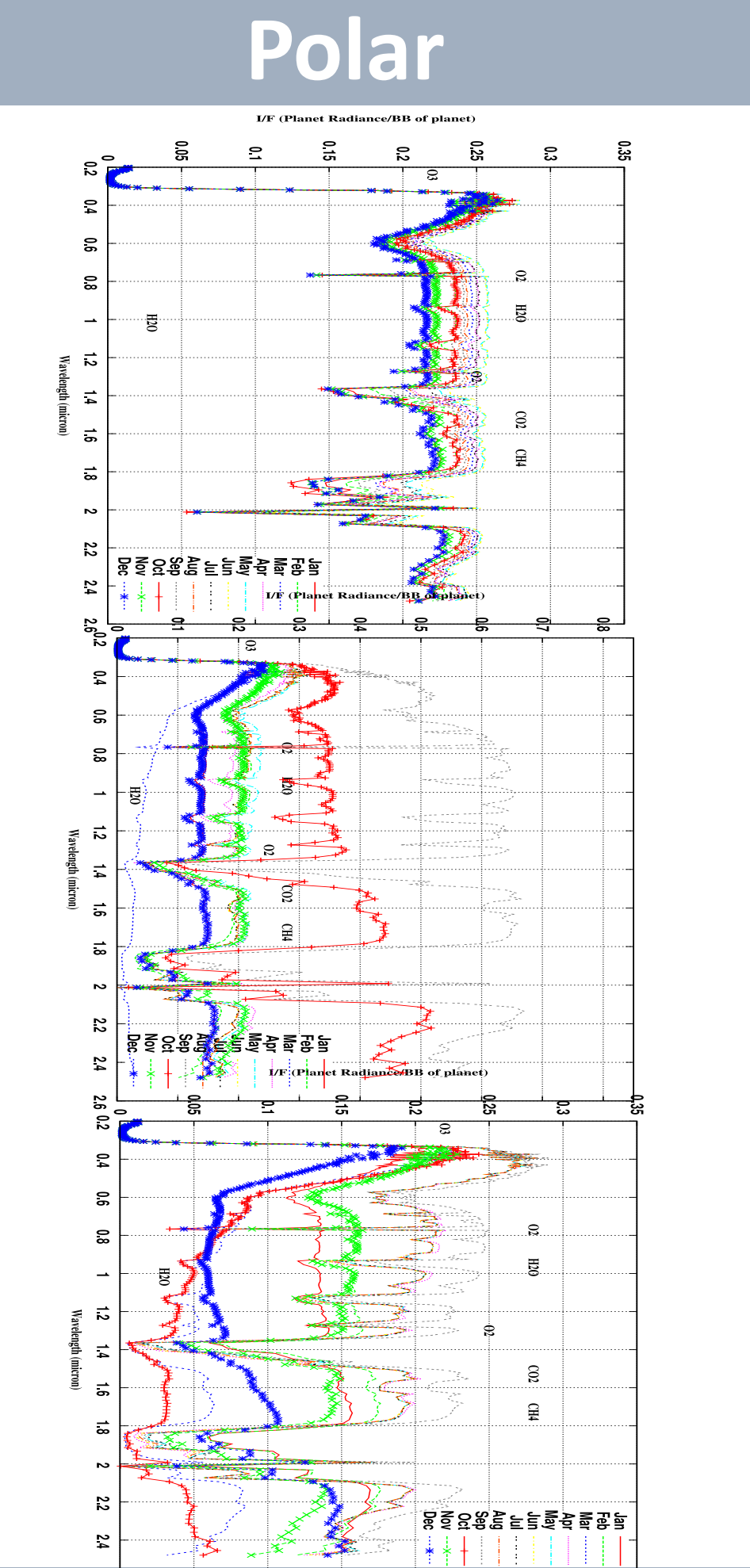
Changes to Planetary Reflectance Spectrum:

- At polar latitudes, the Earth-like (1x) case has modest spectral variation with season, but dramatic variations at longer day lengths/rotation periods.
- This variation is due to rotation rate-dependent seasonal variations in cloud and snow/ice coverage and phase angle effects.
- Changes at equatorial latitudes are more muted and primarily driven by patterns of cloud cover.
- Comparison of SMART and PSG spectra helps determine the robustness of the features

1x

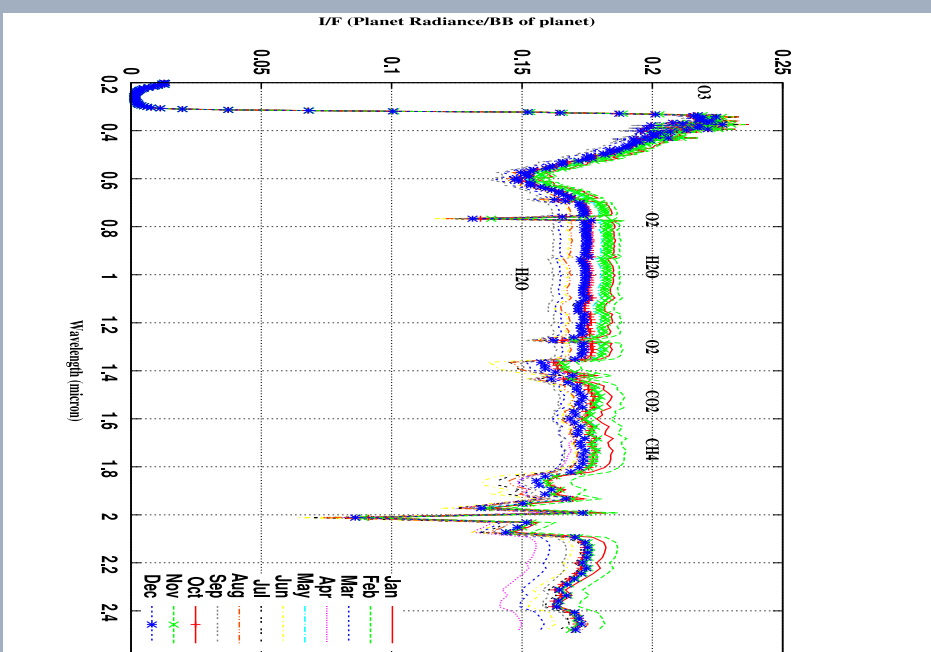
64x

365x



Equatorial

Planetary Spectrum Generator



SMART

